

Redescription and Range Extension of *Spirocamallanus istiblenni* Noble, 1966 (Nematoda: Camallanidae) from Coral Reef Fishes in the Pacific

MARK C. RIGBY^{1,2,4} AND WILLIAM F. FONT³

¹ Department of Biological Sciences, University of Alberta, Edmonton, Alberta, Canada T6G 2E9,

² CRIOBE, BP 1013, Papetoai Moorea, Polynésie Française, and

³ Department of Biological Sciences, Southeastern Louisiana University, Hammond, Louisiana 70402
(e-mail: wffont@selu.edu)

ABSTRACT: The coral reef fish parasite *Spirocamallanus istiblenni* Noble, 1966 (Nematoda: Camallanidae) is redescribed from the type host (*Istiblennius zebra* [Blennidae]) and locality (O'ahu, Hawai'i). This nematode is also reported here from *Entomacrodus marmoratus* (Blennidae) and *Eleotris sandwicensis* (Eleotridae) from Hawai'i; *Bothus pantherinus* (Bothidae) from Fiji; and *Zebbrasoma scopas* (Acanthuridae), *Bothus mancus*, *B. pantherinus* (Bothidae), *Lutjanus kasmira* (Lutjanidae), and *Mulloidides flavolineatus* (Mullidae) from Moorea in French Polynesia. *Spirocamallanus istiblenni* is here reported for the first time from Fiji and French Polynesia. *Spirocamallanus philippinensis* Velasquez, 1980, is regarded as a species *inquirenda*.

KEY WORDS: Nematoda, Camallanidae, *Spirocamallanus istiblenni*, coral reef fishes, Fiji, French Polynesia, Hawai'i.

The intestinal parasite *Spirocamallanus istiblenni* Noble, 1966 (Nematoda: Camallanidae) was found in helminth surveys of coral reef associated fishes in Fiji (Suva Bay), Moorea (in the Society Islands of French Polynesia), and the islands of Hawai'i and O'ahu. Previously, this nematode has been reported from a blenny in O'ahu (Noble, 1966) and a wide variety of coral reef associated fishes in Okinawa, Japan (Hasegawa et al., 1991). While this parasite appears to have both a wide geographic distribution and host species range, and should therefore be well known to parasitologists studying fishes in the south Pacific, the available description of the species is not entirely diagnostic nor could diagnostic features be easily discerned from the syntypes deposited in the United States National Parasite Collection (USNPC). Thus, we redescribe *S. istiblenni* recovered from the type host in the type locality (the zebra blenny, *Istiblennius zebra* [Blennidae], in O'ahu, Hawai'i) and present measurements from conspecific worms from other host coral reef fishes in other localities in the south Pacific.

Materials and Methods

Nematodes from Moorea were killed in hot 70% EtOH and stored in 70% EtOH and 5% glycerin; those

from Hawai'i were killed in Berland's fluid (9 parts glacial acetic acid: 1 part 100% formalin) and stored in 70% EtOH and 5% glycerin; and those from Fiji were killed in hot Bouin's fluid and stored in 70% EtOH. All nematodes were examined as temporary whole mounts in glycerin after clearing in alcohol-glycerin-phenol. Line drawings were made using a drawing tube, scanned into digital format, and final illustrations were prepared with Adobe Illustrator[®]. Measurements given are means and standard deviations followed by ranges in parentheses. All measurements are in micrometers.

Syntypes of *Spirocamallanus istiblenni* Noble, 1966 (1 male and 1 female, United States National Parasite Collection [USNPC] accession numbers 72590 and 72591, respectively) from *I. zebra* in Hawai'i were examined for the distribution of the male caudal papillae. Voucher specimens of *S. istiblenni* Noble, 1966, from Okinawa, Japan (USNPC 81816, 4 males and 4 females from *Bothus pantherinus*; USNPC 81817, 1 male from *Parapercis cylindrica*; USNPC 81818, 1 male from *Parapercis polythama*; and USNPC 81819, 4 males from *Plectorhynchus picus*), and the type specimens of *S. monotaxis* Olsen, 1952 (1 male and 1 female, USNPC 37251) from *Monotaxis grandoculis* in Hawai'i were also examined for comparative purposes.

Results

Spirocamallanus istiblenni Noble, 1966 (Fig. 1)

REDESCRIPTION: Nematoda, Spirurida, Camallanoidea, Camallanidae, Procamallaninae, *Spirocamallanus*. Translucent red in life. Long slender worms. Anterior portion of buccal capsule thin and transparent in *en face* view with

⁴ Corresponding author and present address: ETH Zürich, Experimentelle Ökologie, ETH-Zentrum NW, CH-8092 Zürich, Switzerland (e-mail: rigby@eco.umnw.ethz.ch)

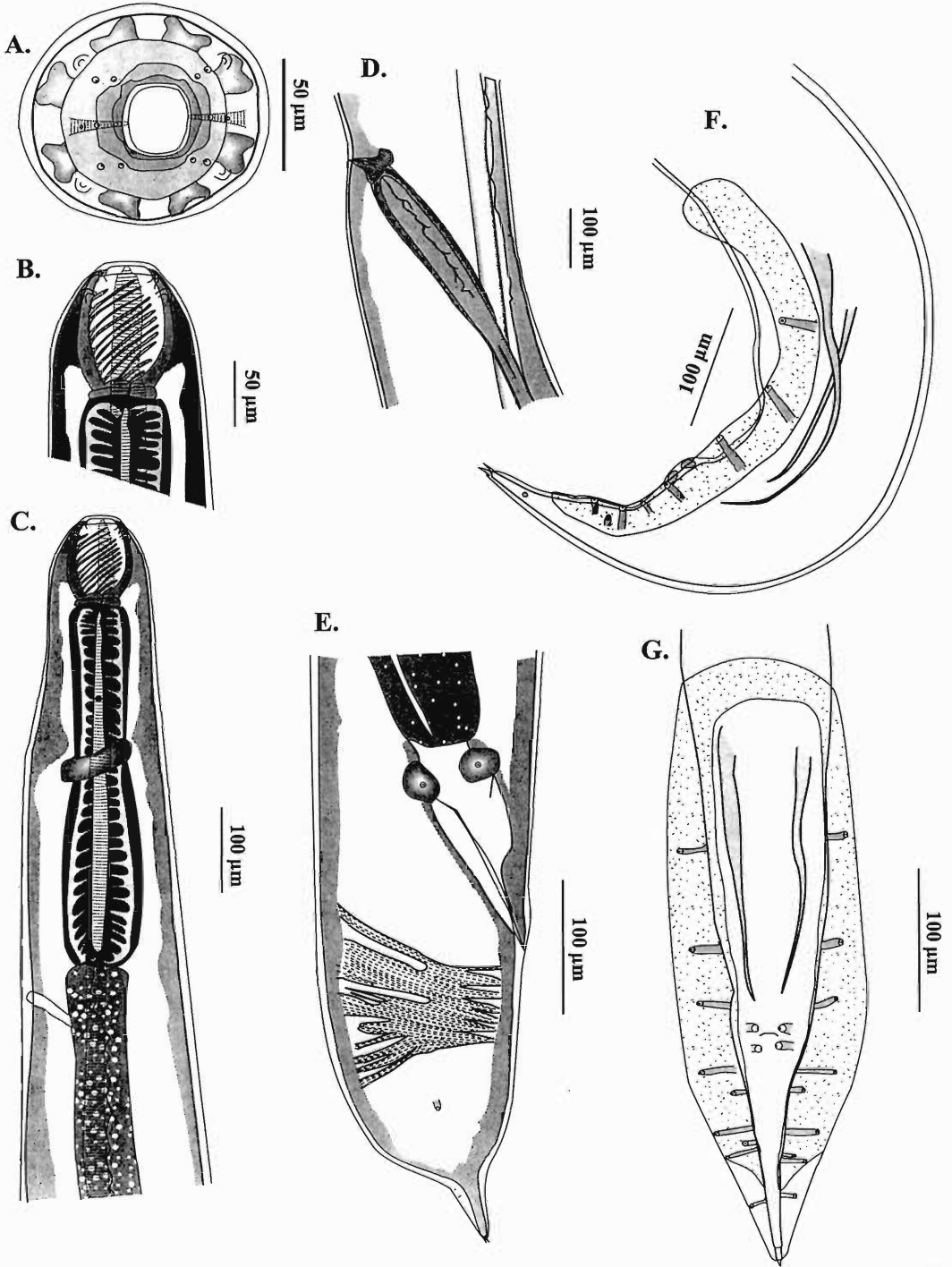


Figure 1. *Spirocamallanus istiblenni* Noble, 1966. A. Apical view of female buccal region. B. Lateral view female buccal region. C. Lateral view of female anterior end. D. Lateral view of vulva from a nongravid female. E. Lateral view of female posterior end. F. Lateral view of male posterior end. G. Ventral view of male posterior end.

lateral cords running to anterior margin of capsule. Oral opening oval to rectangular. Cephalic papillae arranged in 3 concentric rings with 6 papillae in the inner ring and 4 in each of the next 2 rings. Amphids lateral, at level of middle ring of cephalic papillae. Amphidial pouches conspicuous. Median teeth (see Petter and Thatcher [1988]) not seen. Lateral hypodermal cords prominent, running length of worm, rugose. Buccal capsule supported by 8 cuticular reinforcements to which cephalic muscles attach. Buccal capsule elongate, generally longer than wide, greatest width at two-thirds length from anterior margin, lined with spiral ridges (some discontinuous), with basal ring. Two cervical papillae (anterior deirids) present, lateral, usually two-thirds of distance from posterior margin of buccal capsule to nerve ring. Esophagus long and slender; divided into anterior claviform muscular portion and posterior glandular portion. Glandular esophagus projecting slightly into intestine in valve-like formation. Excretory pore near level of junction between muscular and glandular esophagus. Phasmids present. Tail of both sexes terminating with 2 spine-like projections (mucrons), 1 dorsal and 1 ventral, occasionally abraded.

MALE (4 specimens): Length 15,683 \pm 1,335 (14,275–17,491), maximum width near midbody 258 \pm 17 (233–271). Buccal capsule 89 \pm 5 (83–94) long, including ring at base 7 \pm 2 (5–9) long, 71 \pm 1 (70–72) at widest point, length/width ratio 1.25 \pm 0.05 (1.18–1.31). Buccal capsule with 13 \pm 2 (12–15) spirals when counted diagonally, upper fifth smooth. Muscular esophagus 372 \pm 16 (349–384) long, glandular esophagus 593 \pm 51 (549–658) long, ratio 1.59 \pm 0.1 (1.48–1.73). Cervical papillae 190 \pm 22 (173–222) from apex. Nerve ring 244 \pm 10 (230–252) from apex. Excretory pore 518 \pm 35 (477–564) from apex. Anterior flexure of testis 2,324 \pm 664 (1,460–3,072) from apex. Alae well developed, extend 476 \pm 13 (463–491) from posterior extremity, posterior end of alae united ventrally 61 \pm 3 (57–64) from posterior extremity. Caudal papillae 10; 3 preanal pedunculate papillae, 2 adanal pedunculate papillae not attached to alae, 5 postanal pedunculate papillae. Second preanal papilla 65% \pm 4 (60–70) of distance from first to third papillae. First 2 postanal papillae grouped, separated from next 3. Fourth postanal papilla closer to fifth than third postanal papilla, distances between post-

anal papillae variable. Phasmids lateral, slightly posterior to union of alae, 47 \pm 3 (43–50) from posterior extremity. Positions of caudal features measured on one side, expressed as percent of the distance from anterior union of alae to posterior extremity, as follows: first preanal papilla 31 \pm 4 (27–35), second preanal papilla 50 \pm 3 (47–52), third preanal papilla 60 \pm 1 (59–61), anus 63 \pm 1 (63–64), first postanal papilla 72 \pm 2 (69–73), second postanal papilla 76 \pm 1 (75–77), third postanal papilla 79 \pm 2 (77–81), fourth postanal papilla 83 \pm 2 (81–84), fifth postanal papilla 86 \pm 3 (84–89), phasmid 91 \pm 1 (90–92). Spicules 2, unequal, similar in shape, taper to fine point; left spicule (3 specimens) 198 \pm 22 (185–223), right spicule (3 specimens) 281 \pm 20 (263–302), ratio 1.42 \pm 0.07 (1.35–1.50). Gubernaculum absent. Anus 171 \pm 10 (158–181) from posterior extremity. Tail flexed ventrally, with prominent lateral muscle bands, gradually tapers to a point. Terminal spines 3 \pm 0 (3–4) long.

FEMALE (1 specimen): Length 17,110, maximum width near midbody 311. Buccal capsule 101 long, including ring at base 5 long, 76 at widest point, length/width ratio 1.32. Buccal capsule with 15 spirals when counted diagonally, upper fifth smooth. Muscular esophagus 421 long, glandular esophagus 687 long, ratio 1.63. Cervical papillae 193 from apex. Nerve ring 275 from apex. Excretory pore 554 from apex. Anterior flexure of ovary 2,205 from apex. Vulva 7,435 or 43% of body length from apex. Vagina directed posteriorly from vulva, fusiform, muscular, vagina vera tapers gradually into vagina uterina, vagina vera 356 long, 81 at greatest width, vagina uterina 1,595 long, 25 wide. Uterus amphidelphic, posterior ovary reduced. Larvae present within voluminous uterus, occupying most of body cavity and obscuring ovary. Anus 167 from base of terminal digit, anal muscles prominent. Phasmids lateral, approximately halfway between anus and base of terminal digit, 59 from base of terminal digit. Tail rounded, with digit-like projection 48 long. Terminal spines 4 long.

HOST: *Istiblennius zebra* (Vaillant and Sauvage, 1875) (Perciformes, Blennidae).

SITE IN HOST: Intestines.

LOCALITY: Tide pools on Kaupo Beach near Waimanalo, O'ahu, Hawai'i.

DATE OF COLLECTION: January 1996.

OTHER LOCALITIES AND HOSTS: (1) Hawai'i

Table 1. Comparison of measurements of *Spirocamallanus istiblenni*. Measurements are in micrometers and given as ranges.

| Locality | Host(s) | Noble, 1966 | | Present study | | Fiji |
|--|---------|---------------------------|---------------------------|------------------------------|--------------------------------|---------------------------|
| | | Oahu | Oahu | Hawaii | Hawaii | |
| | | <i>Istiblennius zebra</i> | <i>Istiblennius zebra</i> | <i>Eleotris sandwicensis</i> | <i>Entomacrodus marmoratus</i> | <i>Bothus pantherinus</i> |
| No. infected/examined | | 25/30 | 2/12 | 9/10 | 9/10 | 3/5 |
| Mean intensity | | 5 | 2.0 | 4.6 | 3.5 | 1.7 |
| Specimens examined | m | 5 | 4 | 2 | 6 | 1 |
| | f | 9 | 1 | 5 | 6 | 4 |
| Total length | m | 14,900 | 14,274–17,491 | 8,334–9,802 | 8,118–12,255 | 14,494 |
| | f | 21,500 | 17,110 | 10,635–18,834 | 13,196–19,011 | 17,475–20,087 |
| Buccal capsule | m | 75 × 72 | 83–94 × 70–72 | 60–61 × 49–53 | 81–99 × 62–71 | 76 × 54 |
| | f | 77 × 77 | 101 × 76 | 67–74 × 58–60 | 85–101 × 73–79 | 74–90 × 58–64 |
| Buccal spirals | m | 13–14 | 12–15 | 13–15 | 13–16 | 11 |
| | f | 13–14 | 15 | 11–14 | 12–16 | 9–11 |
| Muscular esophagusG | m | 325 | 349–384 | 371–380 | 323–374 | 324 |
| | f | 397 | 421 | 383–496 | 387–463 | 363–419 |
| landular esophagus | m | 485 | 549–658 | 470–479 | 401–601 | 535 |
| | f | 588 | 687 | 519–723 | 599–683 | 451–669 |
| Ratio G/M esophagi | m | 1.49 | 1.48–1.73 | 1.24–1.29 | 1.13–1.78 | 1.65 |
| | f | 1.48 | 1.63 | 1.28–1.55 | 1.4–1.75 | 1.24–1.72 |
| Deirid | m | | 173–222 | 159 | 174–252 | 177 |
| | f | | 193 | 156–200 | 163–208 | 141–218 |
| Nerve ring | m | 208 | 230–252 | 214 | 243–305 | 214 |
| | f | 220 | 275 | 205–255 | 235–252 | 231–263 |
| Excretory pore | m | 400 | 477–564 | 356–452 | 408–501 | |
| | f | 400 | 554 | 404–543 | 497–550 | 457–506 |
| Alae | | 400* | 463–491 | 391–393 | 407–474 | 384 |
| Spicule | l | 184 | 185–223 | 159–170 | 171–203 | 171 |
| | r | 274 | 263–302 | 260–266 | 273–297 | 225 |
| Spicule ratio | | 1.49 | 1.35–1.5 | 1.53–1.67 | 1.4–1.62 | 1.32 |
| 2nd preanal papilla relative to 1st and 3rd | | 74%* | 61–70% | 64–69% | 64–74% | 60% |
| Vulva % | | 38% | 43% | 46–51% | 41–44% | 36–48% |

* : Indicates our measurements.

from *Entomacrodus marmoratus* (Perciformes, Blennidae) and *Eleotris sandwicensis* (Eleotridae); (2) Fiji from *Bothus pantherinus* (Pleuronectiformes, Bothidae); and (3) Moorea in French Polynesia from *Zebrasoma scopas* (Perciformes, Acanthuridae), *Lutjanus kasmira* (Lutjanidae), *Mulloides flavolineatus* (Mullidae), *Bothus mancus*, and *B. pantherinus* (Pleuronectiformes, Bothidae).

SPECIMENS DEPOSITED: (1) Hawai'i, 1 male and 1 female each from *Istiblennius zebra* (USNPC 86742), *Entomacrodus marmoratus* (Muséum National D'Histoire Naturelle [MNHN] 505 HF, USNPC 86743), *Eleotris sandwicensis* (MNHN 506 HF, USNPC 86744); (2) Fiji, 1 male and 1 female from *Bothus pantherinus* (USNPC 86747); and (3) Moorea in French Polynesia, 1 male and 1 female each

from *Lutjanus kasmira* (MNHN 509 HF, USNPC 86748), *Mulloides flavolineatus* (MNHN 507 HF, USNPC 86745), and *B. pantherinus* (MNHN 508 HF, USNPC 86746).

PREVIOUSLY REPORTED: (1) Hawai'i from *Istiblennius zebra* (Perciformes, Blennidae) (see Noble [1966]) and (2) Okinawa, Japan, from *Valencienna strigata* (Perciformes, Gobiidae), *Plectorhynchus picus*, *Scolopsis bilineatus* (Haemulidae), *Parapercis cylindrica*, *P. polyphthalma* (Pinguipedidae), *Amphiprion clarkii* (Pomacentridae), *Variola albimarginata*, *V. louti* (Serranidae), *Bothus pantherinus* (Pleuronectiformes, Bothidae), and *Soleichthys heterorhinos* (Soleidae) (see Hasegawa et al. [1991]). (Some of this material may represent another species, and these records should be reevaluated.)

REMARKS: Worms similar to those found in

Table 1. Continued.

| | | Noble, 1966 | Present study | | | |
|-------------------------|---|-----------------------------|----------------------|-----------------------|-------------------------|---------------------------------------|
| Locality | | Moorea | Moorea | Moorea | Moorea | Moorea |
| Host(s) | | <i>Zebrasoma scopas</i> | <i>Bothus mancus</i> | <i>B. pantherinus</i> | <i>Lutjanus kasmira</i> | <i>Mulloidies flavoli- neatus</i> |
| No. infected/examined | | 1/18 | 1/1 | 4/4 | 2/2 | 3/5 |
| Mean intensity | | 2 | 5 | 7.5 | 2 | 4.7 |
| Specimens examined | m | 1 | 1 | 6 | 2 | 6 |
| | f | 1 | | 10 | 2 | 3 |
| Total length | m | 19,724 | 23,288 | 9,202–17,523 | 17,629–17,632 | 10,386–17,239 |
| | f | 27,033 | | 14,639–27,902 | 22,105–24,745 | 16,975–35,387 |
| Buccal capsule | m | 67 × 63 | 77 × 72 | 68–86 × 51–78 | 83–86 × 66–67 | 64–70 × 60–67 |
| | f | 70 × 73 | | 75–91 × 97–96 | 87–95 × 81–84 | 74–81 × 79–84 |
| Buccal spirals | m | 15 | 17 | 13–20 | 16–18 | 12–16 |
| | f | 12 | | 8–18 | 11–12 | 12 |
| Muscular esophagus | m | 418 | 442 | 345–466 | 378–386 | 236–402 |
| | f | 456 | | 365–568 | 469–503 | 418–505 |
| Glandular esophagus | m | 560 | 709 | 421–724 | 588–654 | 367–562 |
| | f | 664 | | 487–772 | 764–779 | 442–775 |
| Ratio G/M esophagi | m | 1.34 | 1.6 | 1.14–1.57 | 1.55–1.69 | 1.18–1.56 |
| | f | 1.46 | | 1.19–1.46 | 1.52–1.66 | 1.06–1.53 |
| Deirid | m | 171 | 211 | 128–205 | 160–204 | 124–175 |
| | f | 170 | | 157–226 | 190–199 | 168–209 |
| Nerve ring | m | 248 | 262 | 206–277 | 243–253 | 194–236 |
| | f | 273 | | 233–318 | 278–289 | 254–269 |
| Excretory pore | m | 536 | 634 | 377–556 | 461–507 | 452–491 |
| | f | 645 | | 387–721 | 598–607 | 410–556 |
| Alae | | 496 | 575 | 375–524 | 544–562 | 378–536 |
| Spicule | l | 168 | 167 | 151–185 | 172–177 | 153–185 |
| | r | 264 | 230 | 246–287 | 240–263 | 244–302 |
| Spicule ratio | | 1.57 | 1.38 | 1.36–1.81 | 1.39–1.49 | 1.54–1.78 |
| 2nd preanal papilla | | | | | | |
| relative to 1st and 3rd | | 75% | 81% | 67–70% | 63–69% | 61–71% |
| Vulva % | | 43% | | 38–44% | 45% | 39–40% |

I. zebra were also found in tide pool specimens of *E. marmoratus*, brackish pond and stream mouth specimens of *E. sandwicensis* (but not in freshwater specimens sampled from the same island) from Hawai'i, and in the coral reef associated fishes listed above from Fiji and Moorea. These worms agreed with our specimens from *I. zebra* in number and relative position of caudal papillae; shape of buccal capsule; relative number of buccal capsule spirals; relative positions of the deirid, nerve ring, excretory pore, and vulva; ratio between the 2 portions of the esophagus; shape of the female tail; presence of a terminal digit in the female; 2 tail spines in both sexes; and spicule ratio (Table 1). Despite differing fixation methods among island localities, measurements of the specimens overlapped strongly (Table 1), and the suite of characters used above to identify *S. istiblenni* applied to all specimens examined. Although fixation may

have influenced the size of structures, variation due to differences in fixation was apparently inconsequential in comparison with the variation within specimens treated in the same way. Therefore, fixation method did not significantly affect morphology. Based on these similarities, we believe these worms to be conspecific with those recovered from *I. zebra*, and we regard the differences among the worms as individual or host-induced variation.

Discussion

Twenty-five species of *Spirocamallanus* have been reported from the Indo-Pacific, 4 species of which have been reported from the Pacific with 2 unequal spicules (Andrade-Salas et al., 1994): *Spirocamallanus guttatusi* Andrade-Salas, Peneda-López, and García-Magnanã, 1994, *S. istiblenni*, *S. monotaxis*, and *S. philippinensis* Velasquez, 1980. The present worms agree with

Noble's (1966) measurements of *S. istiblenni* (Table 1), including our measurements of the relative distances among the preanal papillae in Noble's syntypes. Although Noble reported 6 postanal papillae in *S. istiblenni*, 5 postanal papillae and a phasmid (as in our material) were figured and observed in the syntypes. Also, while the third through fifth postanal papillae were figured as being close together by Noble (1966), examination of the syntypes revealed that they were generally further apart and agreed more closely with our specimens. Additionally, from the present material, one of the males examined agreed with the others for all characters examined except that it lacked spicules. Measurements from this individual have been included with the others, as it merely appears to be a mutant lacking spicules. Therefore, we assign our material to *S. istiblenni*.

Our material may be distinguished from *S. guttatusi* by the shorter alae (anterior margin of alae to terminal extremity of worm) (463–491 vs. 610–720), spicules (left spicule: 185–223 vs. 200–260; right spicule: 263–302 vs. 300–350), and the longer vagina vera (356 vs. 100–150) for worms of approximately the same size. The inner rings of cephalic papillae of *S. guttatusi* do not appear to have been figured; however, those cephalic papillae that are figured are in agreement with our material. Our material may also be distinguished from *S. monotaxis* by the arrangement of the preanal caudal papillae (the second preanal papilla, in our material, was 60 to 70% of the distance from the first to the third preanal papilla vs. 35 to 48% in *S. monotaxis* [Rigby and Adamson, in press]). Our material, and other similar worms (e.g., *S. guttatusi* and *S. monotaxis*), cannot be reliably differentiated from the description of *S. philippinensis* except by the anteriorly directed vagina in *S. philippinensis*, which appears to be an artifact of fixation. Since type specimens were not deposited in the USNPC, as stated in the description (Lichtenfels, pers. comm.), *S. philippinensis* should be regarded as *inquirenda*.

Hasegawa et al. (1991) reported *S. istiblenni* from several species of coral reef associated fishes in Okinawa, Japan. In our examination of some of that material (see above), the females examined lacked spinelike projections (mucrons) on the terminal digit, and the distribution of the preanal caudal papillae was not consistent with our concept of this species. In the material

from Okinawa that we examined, the second preanal papilla was 44 to 60% of the distance from the first to the third preanal papillae, whereas in all other material of *S. istiblenni* examined, the second preanal papilla was 60 to 70% of the distance from the first to the third preanal papillae and in all other material of *S. monotaxis* examined, the second preanal papilla was 35 to 48% of the distance from the first to the third preanal papillae (Rigby and Adamson, in press). Additionally, the displacement of the postanal papillae varied more than in *S. istiblenni*. These differences suggest that more than 1 species may be included in their material, possibly including *S. istiblenni*. Therefore, the material from Okinawa should be reexamined. We have not included their published measurements in this paper.

Our records significantly increase the geographic range of *S. istiblenni* to include widely spaced islands in the tropical Pacific Ocean. As this species appears to have a very low host specificity (currently recorded from 8 species from 6 families), and fishes of these families are widespread throughout the Indo-Pacific (e.g., see Myers [1992]), suitable hosts may be found on islands throughout the Indo-Pacific, and further investigation of helminth parasites of coral reef fishes in the Indo-Pacific may reveal a much greater geographic range of these worms. This wide geographic distribution may be achieved through copepod intermediate hosts (Stromberg and Crites, 1973), some of which may be pelagic, and pelagic postcyclic fish hosts (e.g., the related parasitic fish nematode *Camallanus marinus* has been reported from epipelagic carangid fishes [Schmidt and Kuntz, 1969]), which may enhance dispersal.

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